

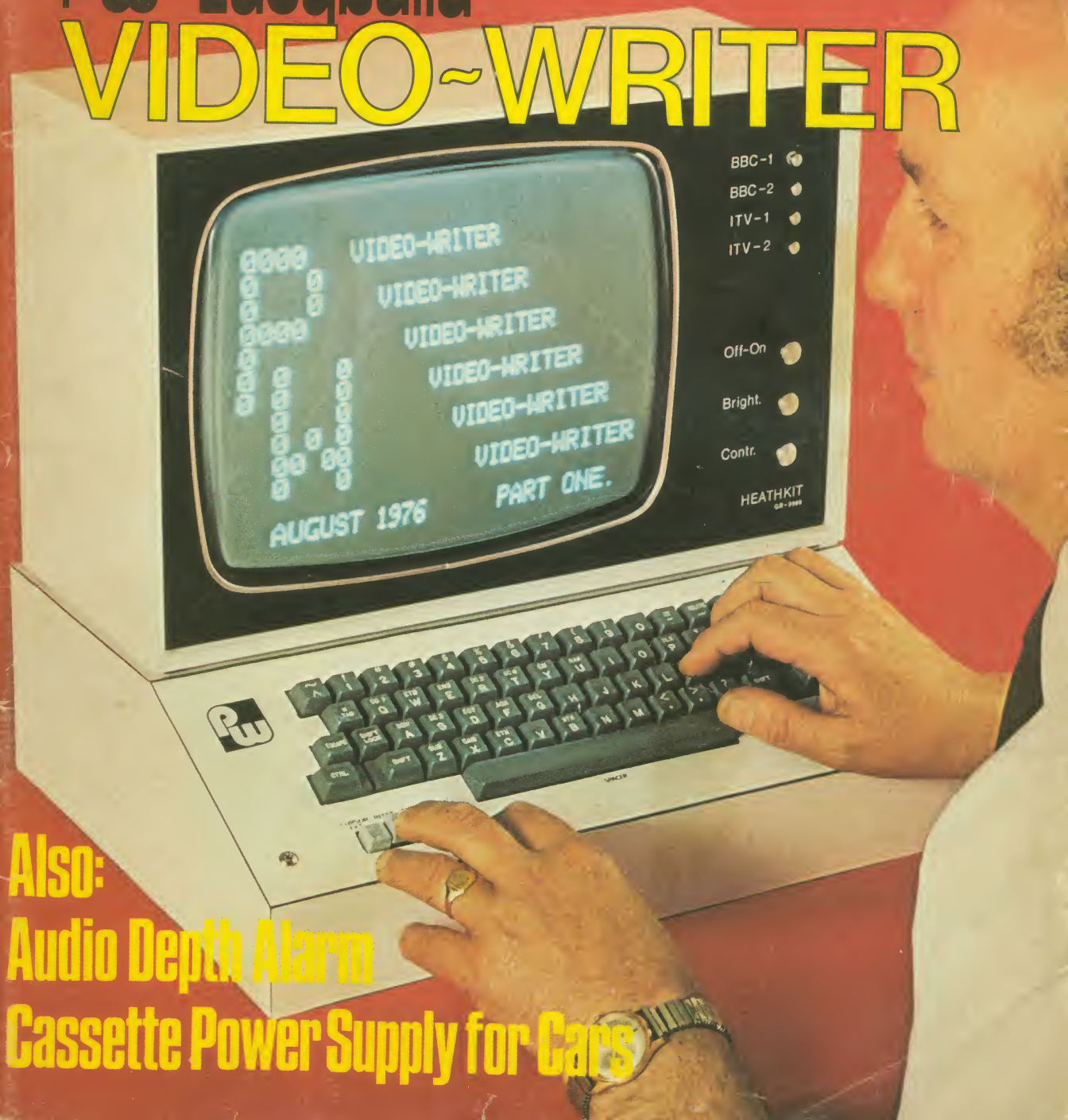
PRACTICAL WIRELESS

AUGUST
1976

35p

PW 'Easybuild'

VIDEO~WRITER



Also:
Audio Depth Alarm
Cassette Power Supply for Cars

The unit resembles a conventional typewriter but it displays its text directly on the screen of a domestic television set or a video monitor. In the former instance connection is made via the aerial socket.

A page of text, which is alpha-numeric with a wide range of punctuation, comprises 16 lines of 32 characters. While one page of text is being displayed a second can be held in memory and this memory capacity can be readily expanded to store extra pages if required. The desired page can be recovered from memory and displayed by manual or electronic switching while the previously displayed page is transferred to memory for later recall.

APPLICATIONS

In its present form:—

1. Displaying information in public areas
2. Shop window advertising
3. Cafe menus and price lists
4. Display of indoor sports scores (darts, bowling, etc.)
5. Silent paging in clubs, hotels, libraries etc.
6. Communications for the deaf and dumb
7. Games—electronic "Scrabble", etc.
8. Captioning closed circuit TV programmes

With certain modifications:—

1. Long distance text communication (via telephone or radio)
2. Interfacing with a micro-processor (for home computer)
3. Home terminal for communicating with Tele-Text system

NOVEL FEATURES

1. Can be assembled at home
2. Constructional cost less than £150
3. Relies, for its economy, on the latest microcircuits
4. Simple animated displays can be presented



THE project to be described is an electronic typewriter which presents its alpha-numeric display on the screen of any British standard 625 line black and white or colour television set. It also produces a standard video level signal which can be fed into an existing closed circuit television system for titling or sub-titling programmes. As the unit incorporates a CCIR standard interlaced sync generator it could be used as the central source of sync pulses for a CCTV system. Reference to the necessary sync drive signals will be made later.

Although the project incorporates sophisticated logic in places, there is nothing which cannot be understood by the amateur with some basic knowledge of logic theory or application.

Construction is very straightforward (most is on printed circuit boards) even though over 50 integrated circuits are used. Apart from the memory circuits, readily available TTL integrated circuits are used throughout. All the semiconductors can be obtained through advertisers in *Practical Wireless* but in the case of the Random Access Memories and the Read Only Memory it might be better to go direct to the distribution.

The only component which might present a problem is the keyboard. These are sometimes advertised by companies dealing in computer surplus and it is worth browsing through advertisements in this and other magazines if you don't want to use the one given in the parts list. There are, also, a couple of alternative approaches which will be described later. In order to simplify the description it will be assumed that the keyboard specified will be used.

STORAGE FACILITY

The unit will display a page of data comprising 16 lines each of 32 characters and, at the same time,

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PW 'Easybuild' VIDEO-WRITER

PART 1

M.J.HUGHES M.A., C.Eng. MIERE

will store a second page in its memory. The displayed page can be interchanged with the stored page at the push of a button and this operation can be carried out under electronic control thus allowing sequential display of the two pages. This allows simple animations to be presented for advertising purposes.

AUXILIARY OPERATIONS

Before attempting to describe the operating principles it might be best to start with a detailed description of how the machine is used. Firstly the output is connected via a coaxial lead to the aerial input socket of a domestic television set and the set tuned to a spare channel, a practice now common for television games. On switch-on the screen is filled with a random selection of letters, numbers and punctuation. To clear the screen it is necessary to depress the spacer bar and while it is held down the auxiliary button marked "Continuous Write" is depressed. This has the effect of writing a "Space" into every memory location for that page thus giving a blank screen. The "Continuous Write" button must be released before the "Spacer Bar" to keep the screen clear. The button marked "Page 1/Page 2" should then be depressed to display the page which had been in store. Again a random selection of letters, etc, will be displayed and this should be cleared in the same manner. Depressing the "Page 1/Page 2"

button once more brings us back to displaying page 1, which is still blank. The only mark on the screen will be the chequered marker we call a "CURSOR". The cursor is used to show where the next symbol will be printed when we depress the typewriter keys. It can be switched off by depressing the "Cursor Extinguish" button if its presence spoils the appearance of the final display.

Normally one would start to type from the top left hand corner of the screen so provision is made to reset the position of the cursor to this point by a single depression of the button marked "Reset". The four "action" buttons mentioned so far (Continuous Write, Page 1/page 2, Cursor Extinguisher and Reset) are grouped in a bank at the bottom left of the panel.

KEYBOARD FUNCTIONS

All other machine functions are initiated by depressing the keyboard buttons. On the keyboard listed, the result of pressing one of the keys is to produce a unique 7-bit binary code on the seven parallel lines feeding from the keyboard to the rest of the equipment.

The codes are standard ASCII, which comprises 7 data bits but, in practice, we shall only use the 6 least significant bits to generate the alpha-numeric characters. The seventh bit serves a purpose in de-



Photograph of authors keyboard and front panel showing the auxiliary function buttons and the Forward/Reverse indicators.

tecting "Non Writing" key functions, i.e. Carriage Return, Cursor Step, Line Feed and Forward/Reverse. When the carriage return key is pressed the cursor jumps back to the extreme left hand side of the screen ready to start a new line of type and the line feed key steps the cursor down to the next line.

One feature of this machine is not found on a conventional typewriter. It is possible to type from left to right or from right to left. This is not because there are Chinese applications in mind but because it is sometimes necessary to back space along a line or step UP several lines to effect a correction. To do this we have built in a Forward/Reverse function which is actuated by depressing the "Tab" button.

A single depression of the button will change the direction of typing and this is displayed on one of the two LEDs, located at the right of the front panel and labelled with arrows indicating "Top to Bottom and Left to Right" or "Bottom to Top and Right to Left". When the former is lit conventional typing can be carried out. Depressing the TAB button will cause the latter to light. Now the Line Feed button will step the cursor UP the screen and depressing the keys will cause the cursor to move from right to left. Depressing the Tab button a second time will put the unit back to normal operation.

It should be understood that use of the spacer bar is not an inert operation, i.e. when it is depressed the cursor will move from left to right (or right to left if in reverse mode) and on a blank screen will not produce any characters but if stepped over the top of any characters that are already present on a line it will erase them by writing a "Space" into memory at that point. In order to step backwards and forwards along a line to position the cursor in readiness for a correction we need a "Non Writing" horizontal step mechanism and for this we use the code generated by the "Back Space" key. To avoid confusion we shall call this key "Cursor Step".

Carriage Return is NOT affected by the Forward/Reverse mode and will always return the cursor to the left hand side of the screen. As said previously the selection of these non-writing instructions is done by detecting the seventh bit of the ASCII code. The remaining 6 bits give 64 permutations of binary coding to describe the 26 letters of the alphabet, the 10 numerals from 0 to 9, a writing "Space" and a host of punctuation and special symbols, asterisk, mathematical signs and, because we are using components produced in America, a "dollar" sign!

Because of self-imposed price restrictions we have limited the display to "Upper Case" only (capitals), but with the keyboard listed it is not necessary to have the "Shift Lock" key depressed. Numerals are already in lower case as on a conventional keyboard and punctuation is sometimes upper and sometimes lower, again as normal. With alternative keyboards it may be necessary to depress the Shift Lock key to type letters. (The complete character font is shown in Fig. 4).

Apart from the special Forward/Reverse function and the fact that one has to carry out a TWO stage operation to get to the next line (Carriage Return followed by Line Feed) typing is carried out exactly as normal. When a line is filled with characters surplus letters or numbers will be "Overprinted" on top of each other in the extreme right hand position, each erasing the previous symbol, hence the operator has to be careful not to overfill a line! Likewise when the bottom of the screen is reached (line 16) an unwary operator could overprint the line. No warnings

have been built in to guard against these possibilities. Such alarms are possible but in view of the additional expense and circuitry involved it was not felt necessary to incorporate them.

Provision was made in the prototype for four other auxiliary functions hence the bank of four push-buttons to the bottom right of the keyboard. These are not used in the basic unit.

CHARACTER GENERATION

Now that the reader has a basic grasp of what we are to expect from the machine it will be easier to describe its operation. Refer to Fig. 1 which shows how a character is generated within the television raster. A television picture is made up of two interlacing fields each containing $312\frac{1}{2}$ lines giving a total of 625 lines. Each line scans from the left to the right of the screen in $64\mu\text{S}$ and it takes 20mS to generate the $312\frac{1}{2}$ successive lines to complete a field. In practice the second field of an interlaced pair has its set of lines positioned between the lines drawn by the first field. Odd and even fields are repeated sequentially. In some displays of this type it is not considered necessary to bother about interlaced scanning because it does not make a great difference to the resolution. For the comparatively little extra cost, it was felt useful to incorporate the special synchronisation signals to facilitate interlacing for the benefit of those who might want to use the unit to caption normal television productions. Because there is basically no difference between the signals that define the characters on an interlaced or non-interlaced system we shall describe how the characters are generated in a single field (whether odd or even).

Each character is made by brightening up the screen at specific "Picture Points" as the raster lines are generated. A symbol is defined by 5 picture points horizontally and 7 vertically as shown on the matrix describing the letter "E" in Fig. 1. Note that we have built into the basic 5×7 matrix an extra row above the letter, this will form the gap between one line of letters and the next. There is also an extra column to the left of the letter; this will give a blank gap between one letter and its neighbour on the same line. It also allows a bit of time for switching to occur when the memories are accessed before the character is displayed. The complete character, including the "inter-row gap" and the "inter-character gap" thus occupies a cell comprising a matrix of 6×8 picture points. With 32 such cells along a line of text, plus a gap at either end for left and right hand margins, 16 rows of them give the page of text. Again, we shall need a margin at the top and bottom of the screen.

TIME DETERMINATION

If we now consider a single line scan of the TV raster it will be seen that we need $32 \times 6 = 192$ picture points plus the margins to occur within the $64\mu\text{S}$ of the scan period. It is convenient to define the horizontal width of a single picture point in terms of Time along the raster line and if this is $250\mu\text{S}$ we can see that $48\mu\text{S}$ of the $64\mu\text{S}$ line period will be taken up defining the horizontal dimensions of the 32 characters. This allows $16\mu\text{S}$ for the horizontal sync pulse, approx $4.7\mu\text{S}$, and the left and right margins. It is fortunate that such a choice of picture point width gives rise to easy numbers. The

width of a character cell is thus $1.5\mu\text{S}$.

For the vertical disposition of the lines we need $16 \times 8 = 128$ picture points to describe the 16 vertical cells. Because there are $312\frac{1}{2}$ lines to play with it is convenient to allocate 2 raster lines to each picture point. This uses up 256 of the possible $312\frac{1}{2}$ lines leaving sufficient for the field sync pulse train and top and bottom margins.

By judicious use of dividing circuitry we start by generating a master frequency signal of 4MHz, each complete phase of which will produce a picture point and then, by counting down from this frequency, generate line sync pulses, field sync trains, left and right margins, and top and bottom margins. Details of how these dividing circuits work will be given later.

SIGNAL ROUTING

Before going any deeper into how the characters are generated it might be best, now, to consider the overall system as shown, in abbreviated form, in Fig. 2. The heart of the system is the 4MHz oscillator already mentioned. This feeds a set of dividers which produce the line sync pulses, the width of each being 19 picture points at $0.25\mu\text{S}$ giving a line sync width of $4.75\mu\text{S}$ as opposed to the standard $4.70\mu\text{S}$. The error in line sync width is not significant and is probably well within normal tolerances. The same dividing system produces the complex waveforms required for the interlaced field sync train (Broad pulses, Equalisation pulses etc). The mixed line and field sync are fed straight from the sync generator to the Sync Mixer near the output of the unit for

later recombination with the video signal. The sync generator also produces Line Drive and Field Drive signals which are fed to the Address Counter. These drive signals could be extracted and used as a sync source for a complete closed circuit television system!

ADDRESS INFORMATION

The Address Counter produces three main sets of signals and a number of control signals. The three most important sets of signals are called ADDRESSES and are used to define specific points and areas on the television screen within the time of a raster.

It might be convenient to refer back to Fig. 1 showing the dispositions of the character cells on the screen. There are 32 columns of cells numbered sequentially from 0 to 31 inclusive. Similarly there are 16 rows numbered from 0 to 15. The cell that is ringed is thus in column 3 and row 2. These two numbers coordinate the cell and are called its Column and Row Addresses respectively. The Address Counter generates Column Addresses by waiting a discrete number of picture points after the line sync pulse has finished, to allow for a left hand margin, and then counts every six picture points starting off at zero (shown as the binary state 00000—a five bit word—on the output of its counter). After the first group of six picture points (describing the column 0) the Address counter increments by 1 to give the binary number 00001 which is the address for column 1. The counter continues incrementing for every set of six picture points until it reaches the binary number 11111 which corres-

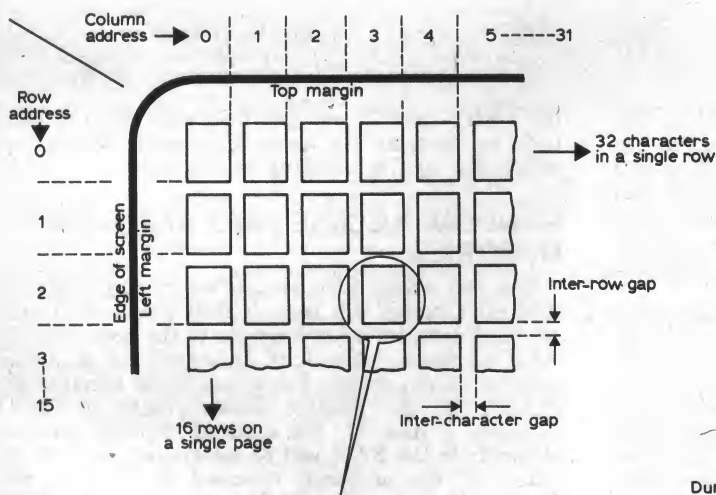
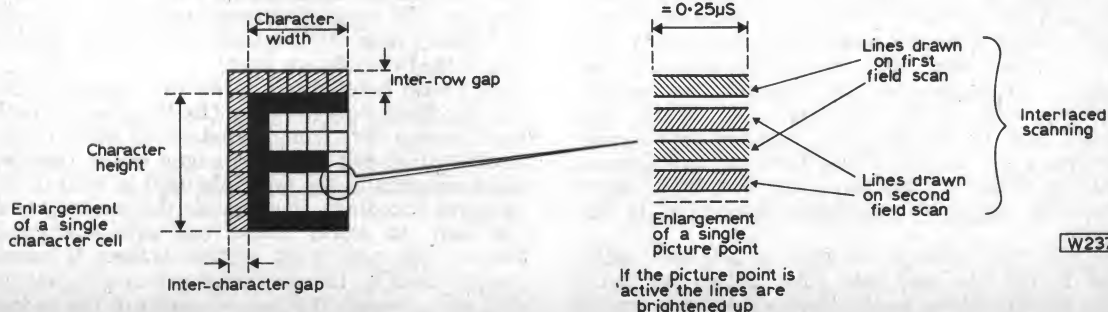


Fig. 1. Principle used in generating a character at a particular position on the screen.



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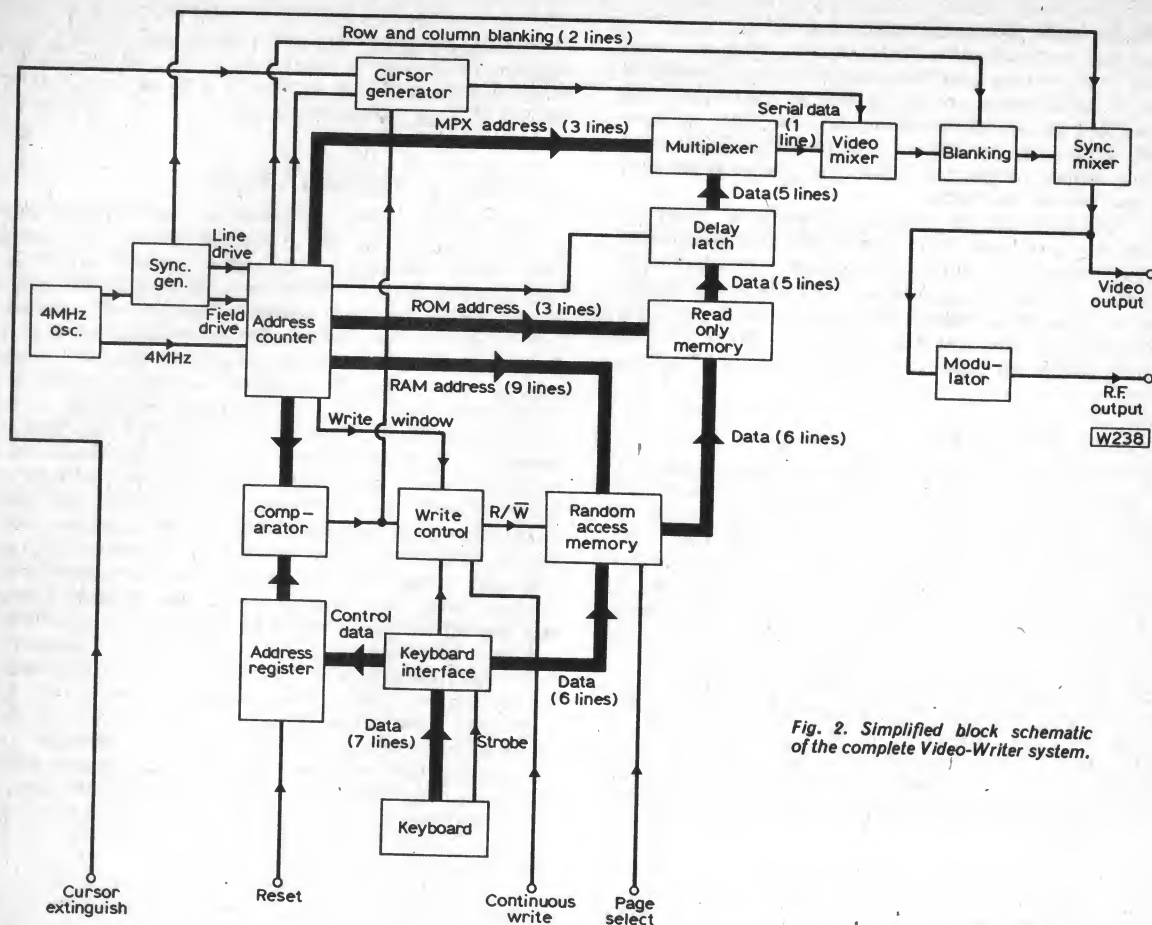


Fig. 2. Simplified block schematic of the complete Video-Writer system.

ponds to the ADDRESS for column 31. Fig. 3. The five wires that carry the 32 codes are fed to the Random Access Memory (RAM) and tell it to give out the codes for the characters that occur in that column. There will, of course, be 16 possible codes depending on which line of text (Row) we are considering and this is where the idea of matrixing comes in.

The Address Counter has a second counter within it which waits a discrete number of lines after the field drive pulse (for the top margin) and then counts up in groups of 16 lines starting with a binary code 0000 (four bits) to describe row address 0. It then increments by one to give the code 0001 which is the address for row 1 and so on up to 1111 (the Address for row 15) Fig. 3. The four wires that carry the 16 possible row addresses are also fed to the RAM and tell it which of the 16 possible characters in the column it should select from its memory. We shall describe later how the codes got into the memory. When the Address Counter reaches the limiting values of its addresses, i.e. 31 for the columns and 15 for the rows, another two signals come into play. These are Row Blanking and Column Blanking. These are used to blank the video signal to prevent unwanted characters appearing in the margins.

Because the Address Counter is precisely referenced to the line and field drive pulses the RAM knows exactly where on the display television screen

the raster spot is and can thus give out the right code to generate the desired character in the cell which the spot is entering at the time.

RANDOM ACCESS AND READ ONLY MEMORIES

The two other main signals emanating from the Address Counter will be described presently. Firstly we must consider what happens to the code that the RAM disgorges when it is addressed for a certain position on the screen. Let us say it has received the address for the position shown ringed in Fig. 1 (Column 3 Row 2). Six separate flip-flop memory elements in the RAM will be interrogated and if the letter "E" was originally intended to appear at this point on the screen the RAM will produce the ASCII code for "E" on its 6 output data lines. This will be the binary code 000101 (only the 6 least significant bits of the full code are used).

This code is fed direct to another type of memory called a Read Only Memory (ROM) which is nothing more than a very complicated set of gates inside an integrated circuit which changes codes (similar in many respects to the principle used in BCD to Seven Segment encoding). Fortunately the constructor does not have to worry about the gate configuration because the unit used in this project is specially programmed by the manufacturer to give out codes that will generate the picture points of the character

★ Collated components list

Resistors

- 1 off 100Ω ½W 10%
- 6 off 330Ω ½W 10%
- 4 off 470Ω ½W 10%
- 3 off 1kΩ ½W 10%
- 1 off 470kΩ ½W 10%

Capacitors

- 1 off 310 pF Compression Trimmer
- 1 off 1,000pF Polystyrene
- 1 off 10μF 12V
- 1 off 47μF 12V
- 1 off 1,000μF 50V
- 1 off 4,700μF 25V

Transistors

- 3 off BC108

Integrated Circuits

Standard TTL

- 6 off 7400
- 4 off 7404
- 3 off 7410
- 1 off 7414
- 2 off 7420
- 10 off 7430
- 2 off 7474
- 3 off 7485
- 4 off 7490
- 4 off 7493
- 1 off 74151
- 1 off 74174
- 4 off 74177
- 3 off 74191

Random Access Memories

- 6 off 2102-2 (650nS access time) Intel or TMS 4034

Texas Instruments

Read Only Memory

- 1 off RO-3-2513 Character Generator, General Instrument Microelectronics

Voltage Regulators

- 2 off 7805 in TO-3 package

Diodes

- 5 off 1N4148
- 1 off Bridge, 100V 3A, RS Components type REC 43 or equiv.
- 1 off 12V 400mW Zener
- 2 off LEDs type MV5025 or similar

Dil Sockets

- 40 off 14 pin
- 14 off 16 pin
- 1 off 24 pin

Coil

- 1 off Denco Aerial Coil type 3T (Blue)

Transformers

- 1 off Miniature 12V 50mA (or 6-6V with centre tap ignored)
- 1 off 9V 2A, Douglas MT-3-AT using 15V and 24V tappings

Switches

- 1 off Mains Rated 2 pole toggle
- 2 off Single pole "push-to-make" RS Components type 338-434
- 2 off Single pole "push-to-make, push-to-break" RS Components type 338-434
- 4 off Buttons to suit
- 1 off Bracket to suit

Keyboard

- 1 off Clare Pendar Keyboard with ASCII encoding ROM and Strobe (see text)

Miscellaneous

- 3 off PCBs, Readers PCB Service
- 2 off heatsinks, Home Radio type TR89 or equiv.
- 1 off UHF Modulator, Crofton Electronics
- Board pins, SRBP, Aluminium, Plugs, Sockets, etc.
- NOTE.—Details of individual component content and identification will be given as the relevant section is issued.

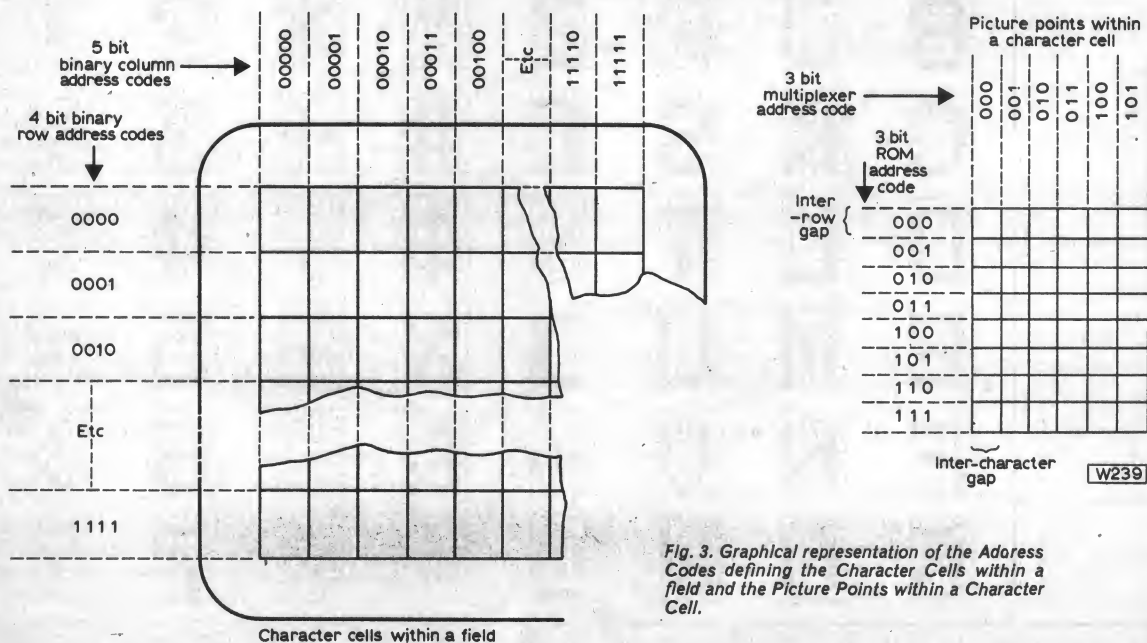


Fig. 3. Graphical representation of the Address Codes defining the Character Cells within a field and the Picture Points within a Character Cell.

that is described by the ASCII code we feed into it. There are 5 lines coming out of the ROM each of which corresponds to a vertical column of picture points within the character we want to describe.

It is not sufficient to have just this information because different rows within the character cell will have different states of picture points, bright or dark. We thus have to tell the ROM which row we are interested in and this depends on which part of the cell the display raster is entering.

Let us assume that we are just entering the top left hand corner of the cell. Our Address Counter tells the ROM this by a 3 bit binary code 000. The ROM is pre-programmed to assume that the top row of picture points in any cell must be blank so it produces an output of "0" on each of its five output lines. The Address Counter is so designed that it will repeat this instruction when the correct position of the next line occurs because we are allowing two lines for every picture point. When the raster gets to the third line the Address Counter changes its ROM ADDRESS output to give the code 001 which instructs the ROM to put out the signals which describe the next row of picture points of the character within the cell.

In the case of "E" all the 5 lines will go to level "1". This is repeated for the fourth line of the raster and on the fifth line the ROM Address is changed

to 010. It will respond by making its output line corresponding to the most left hand column of picture points "1" and the other 4 lines will go to "0". This is duplicated for the sixth line and so on until the last raster line within the cell has been dealt with. Bear in mind that this is not a static operation. As the raster progresses horizontally from cell to cell the address to the RAM will be changing. We are concerning our description only with what happens when the raster gets back to the same cell on subsequent line scans. The same argument could apply to any of the 32 possible cells along a line of text!

LATCH FUNCTIONS

It takes up to $1.25\mu s$ for the RAM and the ROM to respond to their instruction from the Address Counter therefore it is not possible to display the information at the same instance as the memory is addressed. A latch is therefore inserted into the system which "catches" the 5 bits of data from the ROM as they are generated and holds them until the time of the character cell AFTER the address. The timing for this operation is again controlled by the Address Counter. The effect of this latching operation means that an addressing operation is being carried out while the preceding character is being displayed on the screen.

Bit posn. 6 5 3 2 1 4	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
0 0 0								
0 0 1								
0 1 0								
0 1 1								
1 0 0								
1 0 1								
1 1 0								
1 1 1								

Fig. 4. Character Font and the ASCII coding used to designate each character.

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MULTIPLEXING

In order to display the state of the 5 picture points that describe a row within a cell we have to take the 5 lines from the delay latch, which are identical to the input lines except that the data is delayed by one cell width and serialise the information to make the raster spot go bright or dark as is appropriate. This is done with a Multiplexer which is designed to serialise 6 inputs. The extra input corresponds to the inter-character gap (to the left of the character) and is always dark (corresponding to logic level "0"). The six parallel inputs are selected one after another and presented on a single output line by means of a 3 bit binary code generated within the Address Counter.

Code 000 always outputs "0" because this is the inter-character gap; code 001 will cause the most left-hand bit of data describing the picture point of the character to be fed out on the serial line. Code 010 will select the next column within the cell and so on until the sixth code, 101, is reached. This corresponds to the picture point on the extreme right of the cell row in question. Following the code 101 the Multiplexer Address is reset to 000 which is then the inter-character gap for the next character cell which occurs on that particular raster line.

All this happens in synchronism with the line and field drive signals for every picture point within every cell that occurs within that particular field. It only remains to blank the signals during periods when margins should appear on the screen and then mix the sync pulse chain with the data to produce the final television signal. This is normally at video level (1V peak-to-peak) but can be fed to a UHF modulator if aerial socket access to the receiver is desired.

The only part of the system that contributes to the display which has not, as yet, been covered is the Cursor. This requires some knowledge of the Write operation of the instrument which will be described next month.

VISUAL DISPLAY UNITS

Before finishing this part a word ought to be said about the monitor shown in the photograph. It is a Heathkit GR-9900 chosen because of its convenient size, pleasing appearance and because it was exceedingly straightforward to modify it to accept a video level input. It is understood that Heath (Gloucester) Ltd still have a limited number of these kits available for those who wish to make everything for this project. For those who do make use of this kit the modification to allow a video input is to break the printed circuit wiring at the point on the IF/Video/Sound board at the junction between R16 and C18. The video output of the Video-writer is fed directly into C18, the other connection being to the chassis ground. A switch can be connected across the break in the board for normal TV reception. As a transformer is already incorporated in this model there is no worry about chassis isolation.

If the constructor does not wish to use this set as a monitor any domestic 625-line television will do if a modulator is used. **UNDER NO CIRCUMSTANCES** attempt to convert a domestic set to accept video signal unless an isolating transformer is used on the mains input!

Our next issue starts construction information.

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CASSETTE POWER SUPPLY continued from page 309

★ components list

Resistors

R1 2.2K $\frac{1}{4}$ W (see text)
R2 3.3K $\frac{1}{4}$ W (see text)
R3 1 Ω 1W
R4 2.2K $\frac{1}{4}$ W
R5 2.2K $\frac{1}{4}$ W

Capacitors

C1 1000 μ F 16V or 25V (see text)
C2 20 μ F 10V
C3 50 μ F 10V

Semiconductors

D1 1N4001
D2 5.6V 400mW Zener (see text)
Tr1 2N3055, TIP3055, etc.
Tr2 BFX84, BFX52, 2N3053, etc.
Tr3 BC107/8/9 or BC182/3/4
Tr4 as Tr3

Miscellaneous

F1 0.5A anti-surge and holder. PCB (Readers PCB Service). Box to suit. Connecting cable, plugs and sockets. Tr1 insulating kit.

Construction

The circuit was built on a printed circuit board for which a layout is given in Fig. 2. The board itself was mounted in an aluminium box, but any enclosure will do provided adequate provision is made for heatsinking Tr1, which can dissipate 8 to 10W under fault conditions. Tr1 may be any NPN power transistor able to handle 1A at 20V or more. Some of the 'unmarked but tested' types available would be perfectly adequate.

Modifications

The values given are for an output of 6V. To give other voltages, modify values as follows:—

	D2	R1	R2
7.5V	6.8V	1.8k	2.7k
9V	8.2V	1.2k	2.2k

The only critical values in the circuit are R3 and D2, the other values can be altered to the next E12 series value either way without adverse effects.

Mains operation

The circuit can be modified to work from the mains by replacing D1 with a bridge rectifier or 4 $\times$ 1N4001 diodes and supplying it with 8 to 12V AC from a transformer rated at about 0.5A minimum. It may be necessary to increase C1 to about 2500 μ F to avoid hum.

Please mention

PRACTICAL WIRELESS

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